

प्राथमिक बैटरियाँ — सामान्य

(दूसरा पुनरीक्षण)

Primary Batteries — General

(*Second Revision*)

ICS 29.220.10

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भारतीय मानक व्यूरो

BUREAU OF INDIAN STANDARDS

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FOREWORD

Primary Cells and Batteries Sectional Committee, ETD 10

This Indian Standard (Second Revision) was adopted by the Bureau of Indian Standards, after the draft finalized by the Primary Cells and Batteries Sectional Committee had been approved by the Electrotechnical Division Council.

This standard was first published in 1971 and revised in 1984 to align it with the practice followed at the International level. A test to determine resistance to leakage of electrolyte was added. A code of practice for transport, storage, use and disposal of batteries was also added.

During first revision need was felt to evolve a continuous discharge-test for determination of life that would make available the results in a few days' time. In view of the need for such a test, a test method of continuous discharge of batteries was added in this standard for acceptance of lot under acceptance test.

Dry batteries are now available for large varieties of applications which are covered in corresponding IEC standards. This revision has been brought out to align the requirement with corresponding IEC standard to the extent possible.

Considerable assistance has also been taken, while formulating this standard, from IEC 60086-1: 'Primary batteries — Part 1: General'.

Following deviations are made in this standard with respect to requirements given in IEC standard due to specific atmospheric conditions and practices adapted in our country:

- a) Definition of pasted cell added (*see 3.17*)
- b) Cautionary advice applicable to Lithium batteries has been deleted.
- c) Marking regarding method of disposal deleted.
- d) Testing requirements changed to 2 Batteries.
- e) Storage condition and discharge temperature both given at 27° C(Table 4)
- f) Note added on collection of market samples (Table 4)
- g) Applicable temperature for pasted cells added.
- h) For pasted cell temperature changed to 40°C (Table 4)
- j) Criteria for service output changed (for pasted cells)
- k) Time accuracy deleted (Table 7)
- m) Discharge test requirements and procedure added.
- n) Sampling plan and criteria for acceptance changed as per Indian practice
- p) Content is modified to suit to Indian conditions (**E-3**)
- q) Deleted as it is not relevant in India (**E-5.5**)

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS 2 : 1960 'Rules for rounding off numerical values (*revised*)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

Indian Standard

PRIMARY BATTERIES — GENERAL

(Second Revision)

1 SCOPE

This standard specifies requirements to standardize primary batteries with respect to their electrochemical system, dimensions, nomenclature, terminal configurations, markings, test methods, typical performance, safety and environmental aspects.

The objective of this standard is to benefit primary battery users, device designers and battery manufacturers by ensuring that batteries from different manufacturers are interchangeable according to standard form, fit and function. Furthermore, to ensure compliance with the above, this part specifies standard test methods for testing primary cells and batteries.

NOTE — The requirements justifying the inclusion or the ongoing retention of batteries are given in Annex A.

2 REFERENCES

The standards listed below contain provisions which, through reference in this text, constitute provisions of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the standards listed below.

IS No.	Title
2500 (Part 1): 2000	Sampling inspection procedures: Part 1 Attribute sampling plans indexed by acceptable quality limit (AQL) for lot-by-lot inspection
2500 (Part 2): 1965	Sampling inspection procedures: Part 2 Inspection by variables for percent defective
4905 : 2015	Random sampling and randomization procedures (<i>first revision</i>)
8144	Multipurpose dry batteries — Specification (<i>second revision</i>) (<i>under print</i>)
11675 : 1986	Button cells — Silver oxide
15063 : 2001	Alkaline manganese dioxide cells

3 TERMS AND DEFINITIONS

For the purpose of this standard the following definitions shall apply.

3.1 Application Test — Simulation of the actual use of a battery in a specific application.

3.2 Discharge (of a Primary Battery) — Operation during which a battery delivers current to an external circuit.

3.3 Dry (Primary) Battery — Primary battery in which the liquid electrolyte is essentially immobilized.

3.4 Effective Internal Resistance — DC Method Resistance of any electrical component determined by calculating the ratio between the voltage drop ΔU across this component and the range of current Δi passing through this component and causing the voltage drop $R = \Delta U / \Delta i$.

NOTE — As an analogy, the internal d.c. resistance of any electrochemical cell is defined by the following relation:

$$R_i (\Omega) = \frac{\Delta U (V)}{\Delta i (A)} \quad \dots (1)$$

The internal d.c. resistance is illustrated by the schematic voltage transient as given in Fig. 1

As can be seen from Fig. 1, the voltage drop ΔU of the two components differs in nature, as shown in the following relation:

$$\Delta U = \Delta U_Q + \Delta U(t) \quad \dots (2)$$

The first component ΔU_Q for ($t = t_0$) is independent of time, and results from the increase in current Δi according to the relation:

$$\Delta U_Q = \Delta i \times R_Q \quad \dots (3)$$

In this relation R_Q is a pure ohmic resistance. The second component $\Delta U(t)$ is time dependent and is of electrochemical origin.

3.5 End-point Voltage (EV) — Specified voltage of a battery at which the battery discharge is terminated.

3.6 Leakage — Unplanned escape of electrolyte, gas or other material from a battery.

3.7 Minimum Average Duration (MAD) — Minimum average time on discharge which shall be met by a sample of batteries.

NOTE — The discharge test is carried out according to the specified methods or standards and designed to show conformity with the standard applicable to the battery types.

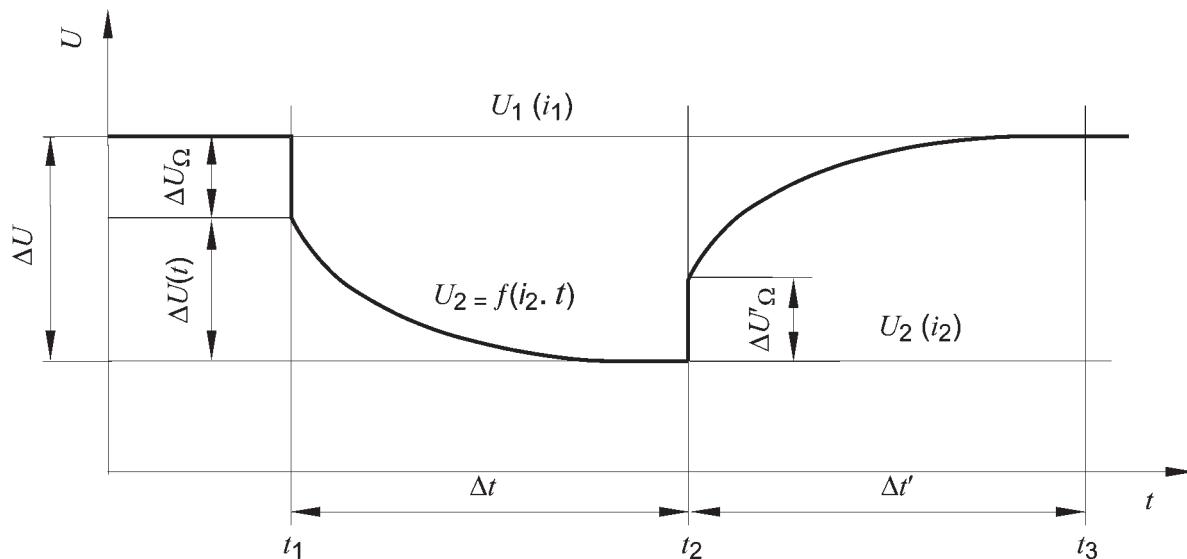


FIG. 1 SCHEMATIC VOLTAGE TRANSIENT

3.8 Nominal Voltage of a Primary Battery V_n — Suitable approximate value of voltage used to identify the voltage of a primary battery.

3.9 On-load Voltage — Closed-circuit Voltage (CCV) — Voltage across the terminals of a battery when it is on discharge.

3.10 Open-circuit Voltage/off-load Voltage (OCV) — Voltage across the terminals of a battery when no current is flowing.

3.11 Primary Battery — One or more primary cells, including case, terminals and marking.

3.12 Primary Cell — Source of electrical energy obtained by the direct conversion of chemical energy that is not designed to be charged by any other electrical source.

3.13 Service Output (of a Primary Battery) — Service life, or capacity, or energy output of a battery under specified conditions of discharge.

3.14 Service Output Test — Test designed to measure the service output of a battery.

NOTE — A service output test may be prescribed, for example, when:

- a) an application test is too complex to replicate; and
- b) the duration of an application test would make it impractical for routine testing purposes.

3.15 Storage Life — Duration under specified conditions at the end of which a battery retains its ability to perform a specified service output.

3.16 Terminals (of a Primary Battery) — Conductive parts provided for the connection of a battery to external conductors.

3.17 Pasted Cell — A type of cell (R 14 and R 20) in which the anode and cathode are physically

separated by cereal paste wetted with electrolyte. It is an Ammonium chloride cell with asphalt sealing.

4 REQUIREMENTS

4.1 General

4.1.1 Design

Primary batteries are sold mainly in consumer markets. In recent years, they have become more sophisticated in both chemistry and construction, for example both capacity and rate capability have increased to meet the growing demands from new, battery-powered equipment technology.

When designing primary batteries, the aforementioned considerations shall be taken into account. Specifically, their dimensional conformity and stability, their physical and electrical performance and their safe operation under normal use and foreseeable misuse conditions shall be assured.

Additionally, information on equipment design can be found in Annex B.

4.1.2 Battery Dimensions

The dimensions for individual types of batteries are given in their respective standards.

4.1.3 Terminals

Terminals shall be in accordance with provisions given in their respective standards

Their physical shape shall be designed in such a way that they ensure that the batteries make and maintain good electrical contact at all times.

They shall be made of materials that provide adequate electrical conductivity and corrosion protection.

4.1.3.1 Contact pressure resistance

Where stated in the battery specification tables, or the individual specification sheets, the following applies:

- A force of 10 N applied through a steel ball of 1 mm diameter at the centre of each contact area for a period of 10 s shall not cause any apparent deformation which might prevent satisfactory operation of the battery.

4.1.3.2 Cap and base

This type of terminal is used for batteries which have the cylindrical side of the battery insulated from the terminals.

4.1.3.3 Cap and case

This type of terminal is used for batteries in which the cylindrical side of the battery forms part of the positive terminal.

4.1.3.4 Screw terminals

This contact consists of a threaded rod in combination with either a metal or insulated metal nut.

4.1.3.5 Flat contacts

These are essentially flat metal surfaces adapted to make electrical contact by suitable contact mechanisms bearing against them.

4.1.3.6 Flat or spiral springs

These contacts comprise flat metal strips or spirally wound wire which is in a form that provides pressure contact.

4.1.3.7 Plug-in-sockets

These are made up of a suitable assembly of metal contacts, mounted in an insulated housing or holding device and adapted to receive corresponding pins of a mating plug.

4.1.3.8 Snap fasteners

These contacts are composed of a combination comprising a stud (non-resilient) for the positive terminal and a socket (resilient) for the negative terminal.

They shall be of suitable metal so as to provide efficient electrical connection when joined to the corresponding parts of an external circuit.

4.1.3.8.1 Spacing of contacts

The spacing between the stud and socket is given in Table 1 and applies from centre to centre. The stud always forms the positive connection and the socket the negative connection on the battery.

Table 1 Spacing of Contacts
(Clause 4.1.3.8.1)

Nominal Voltage V (1)	Standard mm (2)	Miniature mm (3)
9	35 ± 0.4	12.7 ± 0.25

4.1.3.8.2 Non-resilient snap fastener connectors (studs)

All dimensions not specified are free. The shape of the studs shall be chosen so that they conform to the dimensions as shown in Fig. 2 and specified in Table 2.

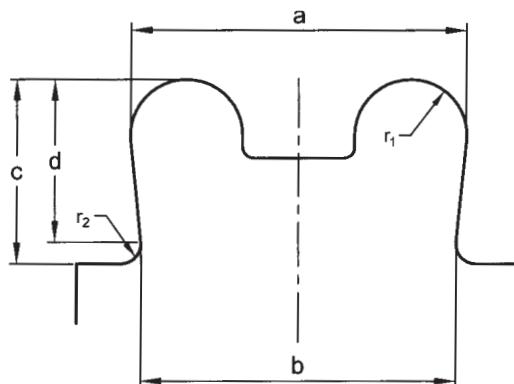


FIG. 2 STUD

Table 2 Snap Fastener Connectors
(Clause 4.1.3.8.2)

S1 No. (1)	Standard mm (3)	Miniature mm (4)
i)	a	7.16 ± 0.05
ii)	b	$6.65^{+0.07}_{-0.05}$
iii)	c	3.20 ± 0.1
iv)	d	2.67 ± 0.05
v)	r_1	$0.61^{+0.05}_{-0.08}$
vi)	r_2	$0.4^{+0.3}_0$

4.1.3.8.3 Resilient snap fastener connectors (sockets)

Dimensions and requirements:

The dimensions of the resilient (socket) parts of snap fastener connectors are not specified as such. The properties shall be such that,

- a) the resiliency ensures that the standardized studs can be properly mated, and
- b) good electrical contact is maintained.

4.1.3.9 Wire

Wire leads shall be single or multi-strand flexible insulated tinned copper. The insulation may be cotton braid or suitable plastic. The positive terminal wire covering shall be red and the negative black.

4.1.3.9.1 Other spring contacts or clips

These contacts are generally used on batteries when the corresponding parts of the external circuit are not precisely known. They shall be of spring brass or of other material having similar properties.

4.1.4 Classification (Electrochemical System)

Primary batteries are classified according to their electrochemical system.

Each system, with the exception of the zinc-ammonium chloride, zinc chloride-manganese dioxide system, has been allocated a letter denoting the particular system.

The electrochemical systems that have been standardized up to now are given in Table 3.

Table 3 Standardized Electrochemical Systems
(Clause 4.1.4)

Sl. No	Letter	Negative Electrode	Electrolyte	Positive Electrode	Nominal Voltage V	Maximum Open Circuit Voltage V
(1)	(2)	(3)	(4)	(5)	(6)	(7)
i)	No letter	Zinc(Zn)	Ammonium chloride, Zinc chloride	Manganese dioxide (MnO ₂)	1.5	1.725
ii)	A	Zinc (Zn)	Ammonium chloride, Zinc chloride	Oxygen (O ₂)	1.4	1.55
iii)	B	Lithium (Li)	Organic electrolyte	Carbon monofluoride (CF) _x	3.0	3.7
iv)	C	Lithium (Li)	Organic electrolyte	Manganese dioxide (MnO ₂)	3.0	3.7
v)	E	Lithium (Li)	Non-aqueous inorganic	Thionyl chloride (SOCl ₂)	3.6	3.9
vi)	F	Lithium (Li)	Organic electrolyte	Iron disulphide (FeS ₂)	1.5	1.83
vii)	G	Lithium (Li)	Organic electrolyte	Copper (II) oxide (CuO)	1.5	2.3
viii)	L	Zinc (Zn)	Alkali metal hydroxide	Manganese dioxide (MnO ₂)	1.5	1.68
ix)	P	Zinc (Zn)	Alkali metal hydroxide	Oxygen (O ₂)	1.4	1.59
x)	S	Zinc (Zn)	Alkali metal hydroxide	Silver oxide (Ag O ₂)	1.55	1.63
xi)	Z	Zinc (Zn)	Alkali metal hydroxide	Nickel oxyhydroxide (NiOOH)	1.5	1.78

NOTES

1 The value of the nominal voltage is not verifiable; therefore it is only given as a reference.

2 The maximum open-circuit voltage is measured as defined in 5.5 and 6.8.1.

3 When referring to an electrochemical system, common protocol is to list negative electrode first, followed by positive electrode, that is lithium-iron disulfide.

4.1.5 Designation

The designation of primary batteries is based on their physical parameters, their electro-chemical system as well as modifiers, if needed.

A comprehensive explanation of the designation system (nomenclature) can be found in Annex C.

4.1.6 Marking

4.1.6.1 With the exception of batteries designated as small, each battery shall be marked with the following information:

- a) Designation;
- b) Expiration of a recommended usage period or year and month or week of manufacture.

NOTES

1 'Mfg. Date of Mfd.' shall mention month and year of manufacture which would be in full or in numeric form and separated by '-' or '/'. The expiry date shall be mentioned and shall be indicated in any of the following manners:

i) Use before 'month and year'.

ii) For batteries having manufacturing date mentioned at the bottom, as:

'Use within..... months of mfg. date at the bottom.'

iii) For batteries having manufacturing date mentioned at the jacket itself as:

'Use within..... months of mfg. date.....'

2 The week of manufacture may be in code.

3

i) The expiry period shall be minimum 12 months from the date of manufacture.

- ii) The expiry period of more than 12 months may also be declared by the manufacturers of batteries.
- iii) The rated life of battery after the period marked after ‘Use before or within’ shall be not less than 70 percent of its rated initial life.”
- c) Polarity of terminals (when applicable);
- d) Nominal voltage; and
- e) Name or trade mark of the manufacturer or supplier.

4.1.6.2 Marking of small batteries

- a) Marking of small batteries shall be done in accordance with the respective standards.
- b) For P-system batteries, 4.1.6.1(a) may be on the battery, the sealing tab or the package, 4.1.6.1(c) may be marked on the sealing tab of the battery and/or on the battery. 4.1.6.1(b), 4.1.6.1(d) and 4.1.6.1(e) may be given on the immediate package instead of on the battery.
- c) Caution for ingestion of small batteries shall be given as per details given in their respective standards.

4.1.6.3 BIS certification marking

4.1.6.3.1 The use of the Standard Mark is governed by the provision of the *Bureau of Indian Standards Act*, 1986 and the rules and regulations made thereunder. The details of condition under which a licence for the use of the Standard Mark may be granted to manufacturers or producers may be obtained from the Bureau of Indian Standards

4.1.7 Interchangeability: Battery Voltage

Primary batteries as can be categorized by their standard discharge voltage U_s (see Note 1). For a new battery system, its interchangeability by voltage is assessed for compliance with the following formula:

$$n \times 0.85 U_r \leq m \times U_s \leq n \times 1.15 U_r$$

where

n = number of cells connected in series, based on reference voltage U_r ;

m = number of cells connected in series, based on standard discharge voltage U_s .

Currently, two voltage ranges that conform to the above formula have been identified. They are identified by reference voltage U_r , which is the mid-point of the following relevant voltage range.

- a) Voltage range 1, $U_r = 1.4$ V: batteries having a standard discharge voltage $m \times U_s$ equal to or within the range of $n \times 1.19$ V to $n \times 1.61$ V.
- b) Voltage range 2, $U_r = 3.2$ V: batteries having a standard discharge voltage $m \times U_s$ equal to

or within the range of $n \times 2.72$ V to $n \times 3.68$ V.

The term standard discharge voltage and related quantities, as well as the methods of their determination, are given in Annex D (see Note 2).

NOTES

- 1 The standard discharge voltage U_s was introduced to comply with the principle of experimental verifiability. Neither the nominal voltage nor the maximum off-load voltage complies with this requirement
- 2 For single-cell batteries and for multi-cell batteries assembled with cells of the same voltage range, m and n will be identical; m and n will be different for multi-cell batteries if assembled with cells from a different voltage range than those of an already standardized battery.

Voltage range 1, encompasses all presently standardized batteries with a nominal voltage of about 1.5 V, that is ‘no-letter’ system, systems A, F, G, L, P, S and Z.

Voltage range 2, encompasses all presently standardized batteries with a nominal voltage of about 3 V, that is systems B, C and E.

Because batteries from voltage range 1 and voltage range 2 show significantly different discharge voltages, they shall be designed to be physically non-interchangeable. Before standardizing a new electrochemical system, its standard discharge voltage shall be determined in accordance with the procedure given in Annex D to resolve its interchangeability by voltage.

WARNING — Failure to comply with this requirement can present safety hazards to the user, such as fire, explosion, leakage and/or device damage. This requirement is necessary for safety and operational reasons.

4.2 Performance

4.2.1 Discharge Performance

Discharge performance of primary batteries is specified in their respective standards.

4.2.2 Dimensional Stability

The dimensions of batteries shall conform with the relevant specified dimensions as given in their respective standards at all times during discharge testing under the standard conditions given in this standard.

NOTES

- 1 An increase in battery height of 0.25 mm can occur with button cells of the B, C, G, L, P and S systems, if discharged below end point voltage.
- 2 For certain button cells (coin cells) of the C and B systems, a decrease in battery height may occur as discharge continues.

4.2.3 Leakage

When batteries are stored and discharged under the standard conditions given in this standard, no leakage shall occur.

4.2.4 Open-circuit Voltage Limits

The maximum open-circuit voltage of batteries shall not exceed the values given in Table 3.

4.2.5 Service Output

Discharge durations, initial and delayed, of batteries shall meet the requirements given in their respective standards.

5 PERFORMANCE–TESTING

5.1 General

For the preparation of standard methods of measuring performance (SMMP) of consumer goods (*see Annex E*).

5.2 Discharge Testing

The discharge tests in this standard fall into two categories, namely:

- a) application tests; and
- b) service output tests.

In both categories of tests, discharge loads are specified in accordance with 6.4.

The methods of determining the load and test conditions are as follows:

- a) *Application tests*
- 1) The equivalent resistance is calculated from the average current and average operating voltage of the equipment under load.
- 2) The functional end-point voltage and the equivalent resistance value are obtained from the data on all the equipment measured.
- 3) The median class defines the resistance value and the end-point voltage to be used for the discharge test.
- 4) If the data are concentrated in two or more widely separated groups, more than one test may be required.
- 5) In selecting the daily discharge period, the total weekly usage of the equipment is considered.

The daily period then becomes the nearest preferred value (*see 6.5*) to one-seventh of the total weekly usage (*see Note 1*).

In the future, alternative load conditions may become unavoidable. It is also inevitable that the load

characteristics of a particular category of equipment will change with time in a developing technology.

The precise determination of the functional end-point voltage of the equipment is not always possible. The discharge conditions are at best a compromise selected to represent a category of equipment which may have widely divergent characteristics.

Nevertheless, in spite of these limitations, the derived application test is the best approach known for the estimation of battery capability for a particular category of equipment (*see Note 2*).

NOTES

- 1 Some fixed resistance tests have been chosen to permit simplicity of design and ensure reliability of the test equipment, despite the fact that, in specific instances, constant current or constant wattage tests may be a better representation of the application
- 2 In order to minimize the proliferation of application tests, the tests specified should be those accounting for 80 percent of the market by battery designation.
- b) *Service output tests* — For service output tests, the value of the load resistor should be selected such that the service output approximates 30 days.

When full capacity is not realized within the required time scale, the service output may be extended to the shortest suitable duration thereafter by selecting a discharge load of higher ohmic value, as defined in 6.4.

5.3 Conformance Check to a Specified Minimum Average Duration

In order to check the conformance of a battery, any of the application tests or service output tests specified in their respective standards may be chosen.

The test shall be carried out as follows:

- a) Test nine batteries;
- b) Calculate the average without the exclusion of any result;
- c) If this average is equal to or greater than the specified figure and no more than two batteries have a service output of less than 80 percent of the specified figure, the batteries are considered to conform to service output;
- d) If this average is less than 80 percent of the specified figure and/or more than two batteries have a service output of less than 80 percent of the specified figure, repeat the test on another sample of nine batteries and calculate the average as previously;
- e) If the average of this second test is equal to

**Table 4 Conditions for Storage Before and During Discharge Testing
(Clause 6.1)**

Sl No.	Type of Test ¹⁾	Storage Conditions			Discharge Conditions		
		Temperature °C	Relative Humidity Percent ²⁾	Duration	Temperature °C	Relative Humidity ²⁾ Percent	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	
i)	Initial discharge test	27 ± 2 ³⁾	60 ± 15	30 days maximum after date of manufacture	27 ± 2	60 ± 15	
ii)	Delayed discharge test	27 ± 2 ³⁾	60 ± 15	12 months from date of manufacture	27 ± 2	60 ± 15	
iii)	Delayed discharge test (high temperature)	45 ± 2 ⁴⁾	50 ± 15	13 weeks	27 ± 2	60 ± 15	

1) Discharge life, initial or delayed, of samples drawn from the market cannot be compared with the specified MAD values of the relevant standards, as the storage conditions are different in various geographical locations of the country. Market samples shall be collected within 2 months of manufacturing date.

2) Except 'P' system: 60 ± 10 percent RH.

3) During short periods only, the storage temperature may deviate from these limits without exceeding 27 ± 5 °C.

4) Batteries to be stored unpacked. For pasted cell (R14 and R20), applicable temperature would be 40°C in place of 45°C

or greater than the specified figure and no more than two batteries have a service output of less than 80 percent of the specified figure, the batteries are considered to conform to service output;

- f) If the average of the second test is less than the specified figure and/or more than two batteries have a service output of less than 80 percent of the specified figure, the batteries are considered not to conform and no further testing is permitted ; and
- g) For the purposes of verifying compliance with this standard, conditional acceptance may be given after completion of the initial discharge tests.

NOTE — Discharge performance of primary batteries is specified in their respective standards.

5.4 Calculation Method for the Specified Value of Minimum Average Duration

This method is described in Annex F.

5.5 OCV Testing

Open-circuit voltage shall be measured with the voltage measuring equipment specified in 6.8.1.

5.6 Battery Dimensions

Dimensions shall be measured with the measuring equipment specified in 6.8.2.

5.7 Leakage and Deformation

After the service output has been determined under the specified environmental conditions, the discharge shall be continued in the same way until

the closed circuit voltage drops for the first time below 40 percent of the nominal voltage of the battery. The requirements of 4.1.3 and 4.2.3 shall be met.

6 PERFORMANCE—TEST CONDITIONS

6.1 Pre-discharge Conditioning

Storage before discharge testing, and the actual discharge test, is carried out under well-defined conditions. Unless otherwise specified, the conditions given in Table 4 shall apply. The discharge conditions shown are further referred to as standard conditions.

6.2 Commencement of Discharge Tests after Storage

Initial discharge tests shall start within 4 weeks from the date of manufacture.

The period between the completion of storage and the start of a delayed discharge test shall not exceed 14 days.

During this period the batteries shall be kept at 27 ± 2 °C and 60 ± 15 percent RH (except for P-system batteries where the relative humidity shall be 60 ± 10 percent RH).

At least one day in these conditions shall be allowed for normalization before starting a discharge test after storage at high temperature.

6.3 Discharge Test Conditions

In order to test a battery it shall be discharged as specified in their respective standards until the voltage on load drops for the first time below the

Table 5 Resistive Loads for New Tests
(Clause 6.4)

Resistance Values					All values in ohms.			
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
i)	1.00	1.10	1.20	1.30	1.50	1.60	1.80	2.00
ii)	2.20	2.40	2.70	3.00	3.30	3.60	3.90	4.30
iii)	4.70	5.10	5.60	6.20	6.80	7.50	8.20	9.10

specified end point. The service output may be expressed as a duration in number of pulses, minutes, hours, days. Duration shall include the full discharge period of the day, during which the voltage drops below the specified end voltage for the first time.

When more than one discharge test are specified, batteries shall meet all of these requirements in order to comply with this standard.

6.4 Load Resistance

The value of the resistive load (which includes all parts of the external circuit) shall be as specified in the relevant specification sheet and shall be accurate to ± 0.5 percent.

When formulating new tests, the resistive load shall, whenever possible, be as shown in Table 5 together with their decimal multiples or sub-multiples.

6.5 Time Periods

The periods on-discharge and off-discharge shall be as specified in their respective standards.

When formulating new tests, whenever possible, one of the following daily periods as given in Table 6 should be adopted.

Table 6 Time Periods for New Tests
(Clause 6.5)

Time	Time	Time	Time
(1)	(2)	(3)	(4)
i) 1 min	5 min	10 min	30 min
ii) 1 h	2 h	4 h	24 h (continuous)

Other cases are specified in their respective standards, if necessary.

6.6 Test Condition Tolerances

Unless otherwise specified, the tolerances given in Table 7 shall apply.

6.7 Activation of 'P' System Batteries

A period of at least 10 min shall elapse between activation and the commencement of electrical measurement.

Table 7 Test Condition Tolerances
(Clause 6.6)

S1 No.	Test Parameter	Tolerance
(1)	(2)	(3)
i)	Temperature	± 2 °C
ii)	Load	± 0.5 percent
iii)	Voltage	± 0.5 percent
iv)	Relative humidity	± 15 percent

NOTE — Except "P" system ± 10 percent.

6.8 Measuring Equipment

6.8.1 Voltage Measurement

The accuracy of the measuring equipment shall be ≤ 0.25 percent and the precision shall be ≤ 50 percent of the value of the last significant digit. The internal resistance of the measuring instrument shall be ≥ 1 MΩ.

6.8.2 Mechanical Measurement

The accuracy of the measuring equipment shall be ≤ 0.25 percent and the precision shall be ≤ 50 percent of the value of the last significant digit.

6.9 Discharge Test Equipment and Procedure

6.9.1 Clamping

For discharge test, batteries shall be clamped firmly between two clamp holders. Clamps shall be made of materials that provide adequate electrical conductivity and corrosion protection.

6.9.2 Contact Pressure

During discharge constant and adequate pressure shall be applied by clamps.

6.9.3 Discharge Duration

Discharge duration shall be controlled by automatic methods, preferably by computers.

7 SAMPLING AND QUALITY ASSURANCE

7.1 Sampling for Periodical Tests

Sampling and testing of attributes, variables and discharge shall be done in accordance with relevant Indian Standard.

Table 8 Sampling and AQL
(*Clauses 7.2.2 and 7.2.3*)

S1 No.	Lot Size	No. of Samples		n_1+n_2	C_1	C_2	C_3
		n_1	n_2				
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
i)	Up to 300	5	5	10	0	2	2
ii)	301~1000	8	8	16	0	2	2
iii)	1 001~3 000	13	13	26	0	3	4
iv)	3 001~10 000	20	20	40	1	4	5
v)	10 001~35 000	32	32	64	2	5	7
vi)	35 001~150 000	50	50	100	3	7	9
vii)	150 001~500 000	80	80	160	5	9	13
viii)	Above 500 000	125	125	250	7	11	19

7.2 Sampling of Lot Acceptance and AQL

7.2.1 Lot

In any consignment all the batteries of the same designation and rated voltage manufactured by the same factory during the same period shall be grouped together to constitute a lot.

7.2.2 Sampling

Batteries shall be collected at random from each lot in accordance with Table 8. For the purpose of random selection provisions contained in IS 4905 shall be used.

7.2.3 Tests for Confirmation

Batteries shall be drawn according to col 2 of Table 8 and shall be tested for marking (*see 4.1.6*), dimensions and accelerated/lot acceptance tests

(*see the respective standards*)

7.2.4 AQL

If the number of defective batteries is less than or equal to C_1 , lot shall be considered as confirming to the requirement. If the number of defectives in a group is greater than or equal to C_2 , the lot shall be declared to have failed. If the number of defects lies between C_1 and C_2 , further sample to size mentioned in col 3 (n_2) shall be drawn and tested. If the number of defects of the combined samples ($n_1 + n_2$) is greater than or equal to C_3 , the lot shall be rejected, otherwise lot shall be accepted.

8 BATTERY PACKAGING

A guideline for battery packaging, shipment, storage and use is given in Annex G.

ANNEX A

(Clause 1)

GUIDELINES FOR THE STANDARDIZATION OF BATTERIES

A-1 Cells and batteries shall meet the following requirements to justify their initial inclusion or ongoing retention in the IS 6303 series:

- a) Battery is in mass production;
- b) Battery is available in several market places of the world;
- c) Battery is produced currently by at least two independent manufacturers, the patent holder(s) of which shall conform to the relevant requirements regarding patented items; and
- d) Battery is produced in at least two different countries or, alternatively, the battery is

purchased by other international and independent battery manufacturers and sold under their company label.

A-2 Necessary items to include in any new work proposal to standardize a new individual battery:

- a) Conformance statement to items (a) to (d) above;
- b) Designation and electrochemical system;
- c) Dimensions (including drawings);
- d) Discharge conditions; and
- e) Minimum average duration(s).

ANNEX B*(Clause 4.1.1)***EQUIPMENT DESIGN****B-1 TECHNICAL LIAISON**

It is recommended that companies producing battery-powered equipment should maintain close liaison with the battery industry. The capabilities of existing batteries should be taken into account at design inception. Whenever possible, the battery type selected should be one included in the respective standards. The equipment should be permanently marked with the IS designation, grade and size of battery which will give optimum performance.

B-2 BATTERY COMPARTMENT

Battery compartments should be easily accessible. Design compartments so that batteries are easily inserted and do not fall out. The dimensions and design of compartments and contacts should be such that batteries complying with this publication shall be accepted. In particular, the equipment designer should not ignore the tolerances given in this standard, even if a national standard or a battery manufacturer calls for smaller battery tolerances.

The design of the negative contact should make allowance for any recess of the battery terminal.

Equipment intended for use by children should have battery compartments which are tamper-proof.

Clearly indicate the type of battery to use, the correct polarity alignment and directions for insertion.

Use the shape and/or the dimensions of the positive (+) and negative (-) battery terminals in compartment designs to prevent the reverse connection of batteries. Positive (+) and negative (-) battery contacts should be visibly different in form to avoid confusion when inserting batteries.

Battery compartments should be electrically insulated from the electric circuit and positioned so as to minimize possible damage and/or risk of injury. Only the battery terminals should physically contact the electric circuit. Care should be taken in the choice

of materials and the design of contacts to ensure that effective electrical contact is made and maintained under conditions of use even with batteries at the extremes of dimensions permitted by this standard. Battery and equipment terminals should be of compatible material and low electrical resistance.

Battery compartments with parallel connections are not recommended since a wrongly placed battery shall result in charging conditions.

Equipment designed to be powered by air-depolarized batteries of either the 'A' or 'P' system must provide for adequate air access. For the 'A' system, the battery should preferably be in an upright position during normal operation. For 'P' system batteries, positive contact should be made on the side of the battery, so that air access is not impeded.

Although batteries are very much improved regarding their resistance to leakage, it can still occur occasionally. When the battery compartment cannot be completely isolated from the equipment, it should be positioned so as to minimize possible damage.

The battery compartment shall be clearly and permanently marked to show the correct orientation of the batteries. One of the most common causes of dissatisfaction is the reversed placement of one battery in a set, which may result in battery leakage and/or explosion and/or fire. To minimize this hazard, battery compartments should be designed so that a reversed battery shall result in no electrical circuit.

The associated circuitry should not make physical contact with any part of the battery except at the surfaces intended for this purpose.

B-3 VOLTAGE CUT-OFF

In order to prevent leakage resulting from a battery being driven into reverse, the equipment voltage cut-off shall not be below the battery manufacturers' recommendation.

ANNEX C
(Clause 4.1.5)
DESIGNATION SYSTEM (NOMENCLATURE)

C-0 The battery designation system (nomenclature) defines as unambiguously as possible the physical dimensions, shape, electrochemical system, nominal voltage and, where necessary, the type of terminals, rate capability and special characteristics.

The designation system has been divided into two parts:

- a) defines the designation system (nomenclature) in use up to October 1990.
- b) defines the designation system (nomenclature) in use since October 1990 to accommodate present and future needs.

C-1 DESIGNATION SYSTEM IN USE UP TO OCTOBER 1990

This clause applies to all batteries which have been standardized up to October 1990 and shall remain valid for those batteries after that date.

C-1.1 Cells

A cell is designated by a capital letter followed by a number. The letters R, F and S define round, flat (layer built) and square cells, respectively. The letter, together with the following number (*see Note*), is defined by a set of nominal dimensions.

Where a single-cell battery is specified, the maximum dimensions of the battery instead of the nominal dimensions of the cell are given in Tables 9, 10 and 11. Note that these tables do not include electro chemistries, except for the no letter system, or other modifiers. These other parts of the designation system (nomenclature) follow in **C-1.2**, **C-1.3** and **C-1.4**. These tables only provide core physical designations for single cells or single batteries.

NOTE — At the time this system was applied, numbers were allocated sequentially. Omissions in the sequence arise because of deletions or by the different approach of numbering used even before the sequential system.

Table 9 Physical Designation and Dimensions of Round Cells and Batteries
(Clause C-1.1)

Sl No.	Physical Designation	Nominal Cell Dimensions		Maximum Battery Dimensions	
		Diameter	Height	Diameter	Height
(1)	(2)	(3)	(4)	(5)	(6)
i)	R06	10	22	—	—
ii)	R03	—	—	10.5	44.5
iii)	R01	—	—	12.0	14.7
iv)	R0	11	19	—	—
v)	R1	—	—	12.0	30.2
vi)	R3	13.5	25	—	—
vii)	R4	13.5	38	—	—
viii)	R6	—	—	14.5	50.5
ix)	R9	—	—	16.0	6.2
x)	R10	—	—	21.8	37.3
xi)	R12	—	—	21.5	60.0
xii)	R14	—	—	26.2	50.0
xiii)	R15	24	70	—	—
xiv)	R17	25.5	17	—	—
xv)	R18	25.5	83	—	—
xvi)	R19	32	17	—	—
xvii)	R20	—	—	34.2	61.5
xviii)	R22	32	75	—	—
xix)	R25	32	91	—	—
xx)	R26	32	105	—	—
xxi)	R27	32	150	—	—
xxii)	R40	—	—	67.0	172.0
xxiii)	R41	—	—	7.9	3.6
xxiv)	R42	—	—	11.6	3.6
xxv)	R43	—	—	11.6	4.2
xxvi)	R44	—	—	11.6	5.4
xxvii)	R45	9.5	3.6	—	—
xxviii)	R48	—	—	7.9	5.4
xxix)	R50	—	—	16.4	16.8
xxx)	R51	1.5	50.0	—	—
xxxi)	R52	—	—	16.4	11.4
xxxii)	R53	—	—	23.2	6.1
xxxiii)	R54	—	—	11.6	3.05
xxxiiv)	R55	—	—	11.6	2.1
xxxiiv)	R56	—	—	11.6	2.6
xxxiiv)	R57	—	—	9.5	2.7
xxxiiv)	R58	—	—	7.9	2.1
xxxiiv)	R59	—	—	7.9	2.6
xxxiiv)	R60	—	—	6.8	2.15
xli)	R61	7.8	39	—	—
xlii)	R62	—	—	5.8	1.65
xliii)	R63	—	—	5.8	2.15
xliv)	R64	—	—	5.8	2.70
xlv)	R65	—	—	6.8	1.65
xlv)	R66	—	—	6.8	2.60
xlvi)	R67	—	—	7.9	1.65
xlvi)	R68	—	—	9.5	1.65
xlvi)	R69	—	—	9.5	2.10
xlvi)	R70	—	—	5.8	3.6

NOTE — The complete dimensions of these batteries is given in their respective standards

Table 10 Physical Designation and Nominal Overall Dimensions of Flat Cells

(Clause C-1.1)

All dimensions in millimetres.

SI No.	Physical Designation	Diameter	Length	Width	Thickness
(1)	(2)	(3)	(4)	(5)	(6)
i)	F15	—	14.5	14.5	3.0
ii)	F16	—	14.5	14.5	4.5
iii)	F20	—	24	13.5	2.8
iv)	F22	—	24	13.5	6.0
v)	F24	23	—	—	6.0
vi)	F25	—	23	23	6.0
vii)	F30	—	32	21	3.3
viii)	F40	—	32	21	5.3
ix)	F50	—	32	32	3.6
x)	F70	—	43	43	5.6
xi)	F80	—	43	43	6.4
xii)	F90	—	43	43	7.9
xiii)	F92	—	54	37	5.5
xiv)	F95	—	54	38	7.9
xv)	F100	—	60	45	10.4

NOTE — The complete dimensions of these batteries are given in their respective standards.

Table 11 Physical Designation and Dimensions of Square Cells and Batteries

(Clauses C-1.1 and C-1.2)

All dimensions in millimetres.

SI No.	Physical designation	Nominal Cell Dimensions			Maximum Battery Dimensions		
		Length	Width	Height	Length	Width	Height
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
i)	S4	—	—	—	57.0	57.0	125.0
ii)	S6	57	57	150	—	—	—
iii)	S8	—	—	—	85.0	85.0	200.0
iv)	S10	95	95	180	—	—	—

NOTE — The complete dimensions of these batteries is given in their respective standards.

C-1.2 Electrochemical System

With the exception of the zinc-ammonium chloride, zinc chloride-manganese dioxide system, the letters R, F and S are preceded by an additional letter which denotes the electrochemical system. These letters can be found in Table 3.

C-1.3 Batteries

If a battery contains one cell only, the cell designation is used.

If a battery contains more than one cell in series, a numeral denoting the number of cells precedes the cell designation.

If cells are connected in parallel, a numeral denoting the number of parallel groups follows the cell designation and is connected to it by a hyphen.

If a battery contains more than one section, each section is designated separately, with a slash (/) separating their designation.

C-1.4 Modifiers

In order to preserve the unambiguity of the battery designation, variants of one basic type are differentiated by the addition of a letter X or Y to indicate the different arrangements or terminals and C, P or S to indicate different performance characteristics.

C-1.5 Examples

1) R20 — A battery consisting of a single R20-size cell of the zinc-ammonium chloride, zinc chloride-manganese dioxide system.

2) LR20 — A battery consisting of a single R20-size cell of the zinc-alkali metal hydroxide-manganese dioxide system.

3) 3R12 — A battery consisting of three R12-size cells of the zinc-ammonium chloride, zinc chloride-manganese dioxide system, connected in series.

4) 4R25X — A battery consisting of four R25-size cells of the zinc-ammonium chloride, zinc chloride-manganese dioxide system, connected in series and with spiral spring contacts.

C-2 DESIGNATION SYSTEM IN USE SINCE OCTOBER 1990

This clause applies to all batteries considered for standardization after October 1990.

The basis for this designation system (nomenclature) is to convey a mental concept of the battery through the designation system. This is accomplished by using a diameter, from a cylindrical envelope, and a height related concept for all batteries, round (R) and non-round (P).

This clause also applies to single-cell batteries and multi-cell batteries with cells in series and/or parallel connection.

For example a battery of maximum diameter 11.6 mm and a height of maximum 5.4 mm is designated as R1154 preceded by a code for its electrochemical system, as described in this clause are given in Tables 12 and 13.

C-2.1 Round Batteries**C-2.1.1 Round Batteries with Diameter and Height Less than 100 mm**

The designation for round batteries with a diameter and height less than 100 mm is as shown in Fig. 3.

Table 12 Physical Designation and Dimensions of**Round Cells and Batteries Based on C-2**

(Clause C-2)

All dimensions in millimetres.

S1 No.	Physical Designation	Maximum Battery Dimensions	
		Diameter (3)	Height (4)
(1)	(2)		
i)	R772	7.9	7.2
ii)	R1025	10.0	2.5
iii)	R1216	12.5	1.6
iv)	R1220	12.5	2.0
v)	R1225	12.5	2.5
vi)	R1616	16.0	1.6
vii)	R1620	16.0	2.0
viii)	R2012	20.0	1.2
ix)	R2016	20.0	1.6
x)	R2020	20.0	2.0
xi)	R2025	20.0	2.5
xii)	R2032	20.0	3.2
xiii)	R2320	23.0	2.0
xiv)	R2325	23.0	2.5
xv)	R2330	23.0	3.0
xvi)	R2354	23.0	5.4
xvii)	R2420	24.5	2.0
xviii)	R2425	24.5	2.5
xix)	R2430	24.5	3.0
xx)	R2450	24.5	5.0
xxi)	R3032	30.0	3.2
xxii)	R11108	11.6	10.8
xxiii)	2R13252	13.0	25.2
xxiv)	R12A604	12.0	60.4
xxv)	R14250	14.5	25.0
xxvi)	R15H270	15.6	27.0
xxvii)	R17335	17.0	33.5
xxviii)	R17345	17.0	34.5
xxix)	R17450	17.0	45.0

NOTE — The complete dimensions of these batteries is given in their respective standards.

Table 13 Physical Designation and Dimensions of Non-Round Batteries Based on C-2

(Clause C-2)

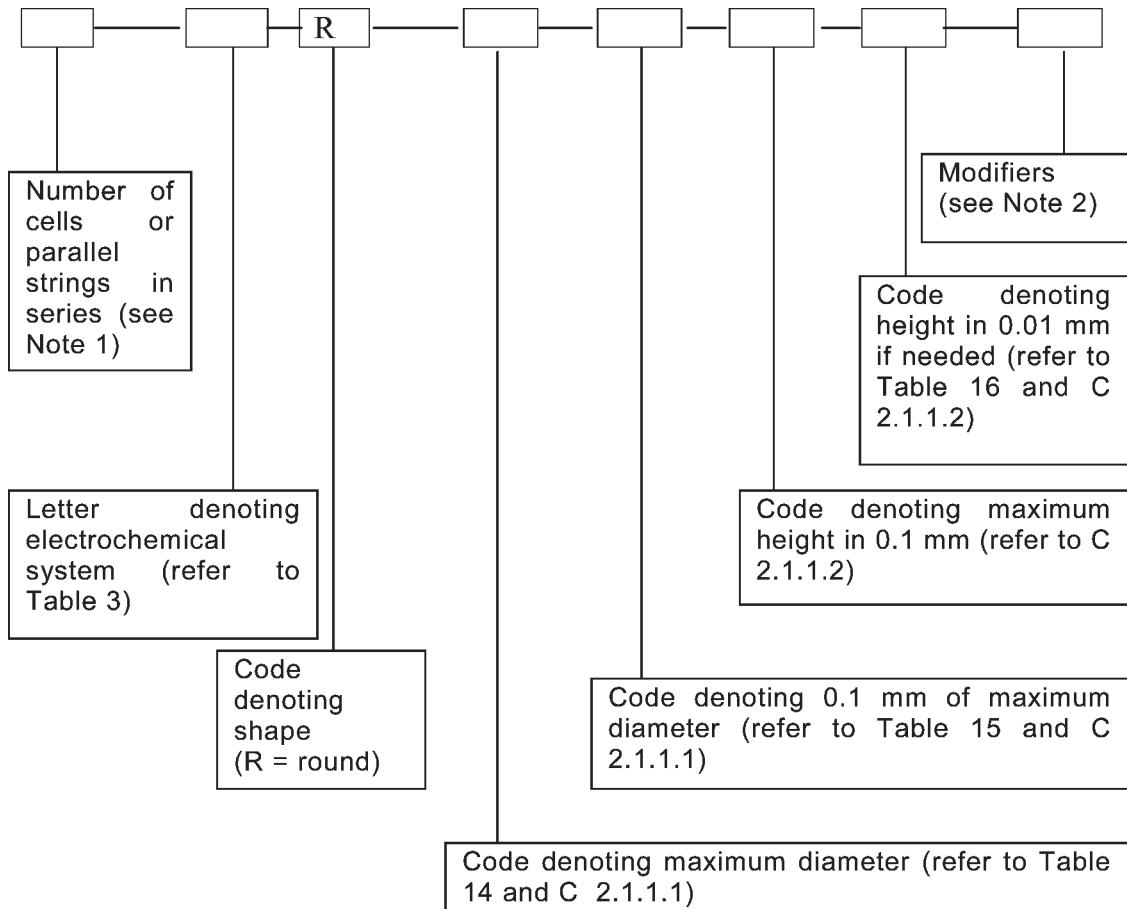
All dimensions in millimetres.

S1 No.	Physical Designation	Designation (Original)	Maximum Battery Dimensions		
			Length (4)	Width (5)	Height (6)
(1)	(2)	(3)			
i)	2P3845	2R5	34.0	17.0	45.0
ii)	2P4036	R-P2	35.0	19.5	36.0

NOTES

1 The actual used designation of these batteries is 2R5 and R-P2 since these batteries were already recognized under these numbers before they were standardized.

2 The complete dimensions of these batteries is given in their respective standards.



NOTES

1 The number of cells or strings in parallel is not specified.

2 Modifiers are included to designate for example specific terminal arrangement, load capability and further special characteristics.

FIG. 3 DESIGNATION SYSTEM FOR ROUND BATTERIES: $\emptyset < 100$ mm; HEIGHT A < 100 mm

C-2.1.1.1 Method for assigning the diameter code

The diameter code is derived from the maximum diameter.

The diameter code number is:

- assigned according to Table 14 in case of a recommended diameter; and
- assigned according to Table 15 in case of a non-recommended diameter.

C-2.1.1.2 Method for assigning the height code

The height code is the number, denoted by the integer of the maximum height of the battery, expressed in tenths of a millimetre (that is 3.2 mm maximum height is denoted 32).

The maximum height is specified as follows:

- For flat contact terminals, the maximum height is the overall height including the terminals; and
- For all other types of terminals, the maximum height is the maximum overall height excluding the terminals (that is shoulder-to-shoulder).

If the height in hundredths of a millimetre needs to be specified, the hundredth of a millimetre may be denoted by a code according to Table 16.

C-2.1.1.3 Examples

Example 1

LR1154: A battery consisting of a round cell or string in parallel with a maximum diameter of 11.6 mm (see

Table 14 Diameter Code for Recommended Diameters

(Clause C-2.1.1.1)

All dimensions in millimetres.

S1 No.	Code	Recommended Diameter	S1 No.	Code	Recommended Diameter
(1)	(2)	(3)	(1)	(2)	(3)
i)	4	4.8	xvii)	20	20.0
ii)	5	5.8	xviii)	21	21.0
iii)	6	6.8	xix)	22	22.0
iv)	7	7.9	xx)	23	23.0
v)	8	8.5	xxi)	24	24.5
vi)	9	9.5	xxii)	25	25.0
vii)	10	10.0	xxiii)	26	26.2
viii)	11	11.6	xxiv)	28	28.0
ix)	12	12.5	xxv)	30	30.0
x)	13	13.0	xxvi)	32	32.0
xi)	14	14.5	xxvii)	34	34.2
xii)	15	15.0	xxviii)	36	36.0
xiii)	16	16.0	xxix)	38	38.0
xiv)	17	17.0	xxx)	40	40.0
xv)	18	18.0	xxxi)	41	41.0
xvi)	19	19.0	xxxii)	67	67.0

Table 15 Diameter Code for Non-Recommended Diameters

(Clause C-2.1.1.1)

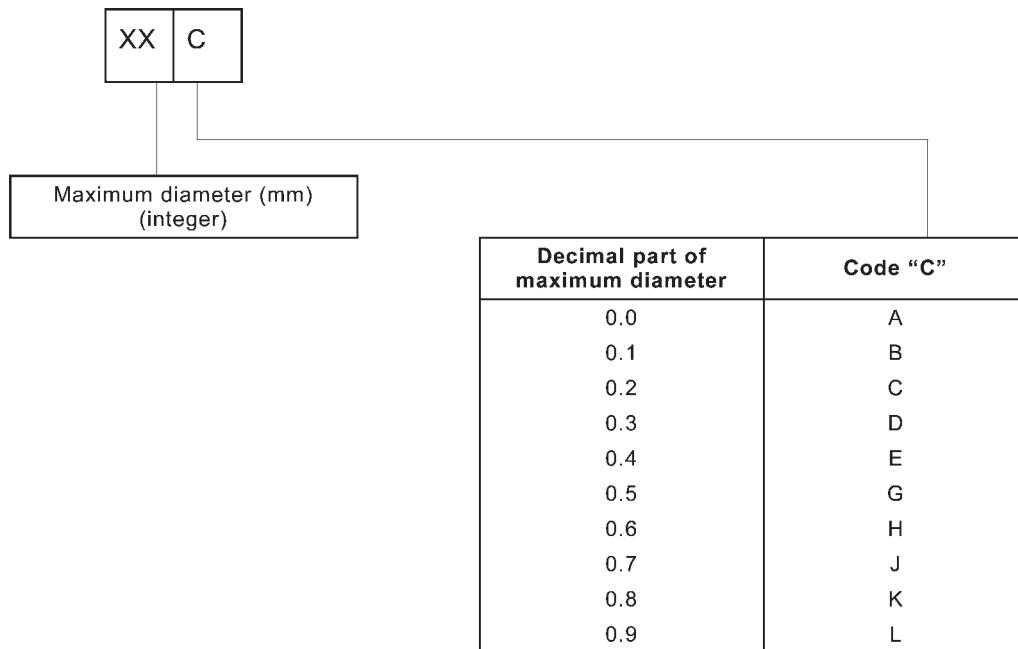


Table 14), and a maximum height of 5.4 mm, of the zinc-alkali metal hydroxide-manganese dioxide system.

Example 2

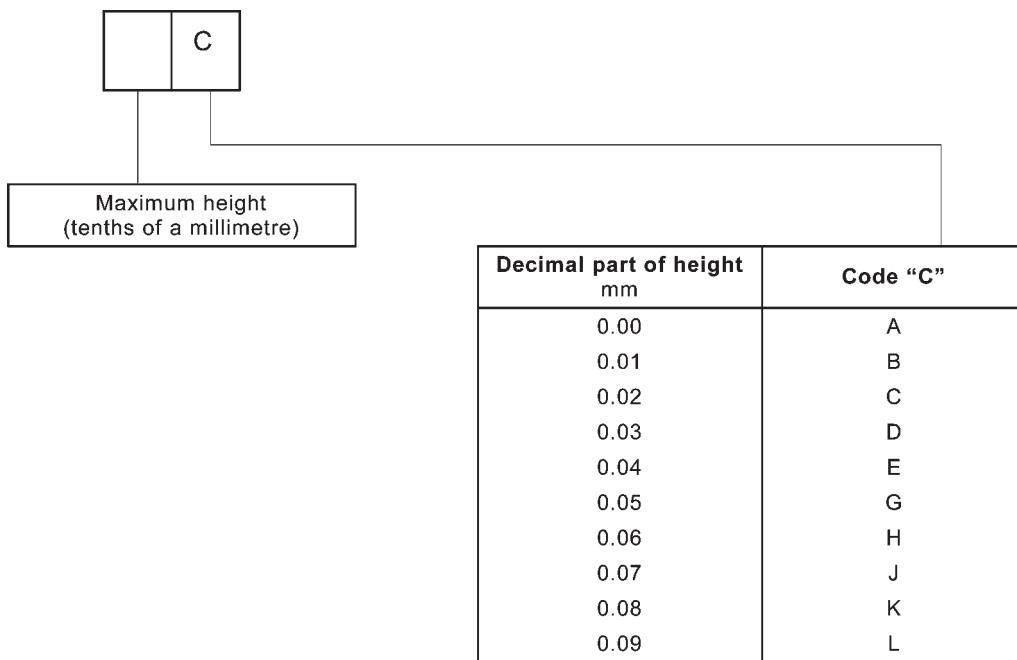
LR27A116: A battery consisting of a round cell or string in parallel with a maximum diameter of 27 mm

(see Table 15) and a maximum height of 11.6 mm, of the zinc-alkali metal hydroxide-manganese dioxide system.

Example 3

LR2616J: A battery consisting of a round cell or string in parallel with a maximum diameter of 26.2 mm (see

Table 16 Height Code for Denoting the Hundredths of a Millimetre of Height
(Clause C-2.1.1.2)

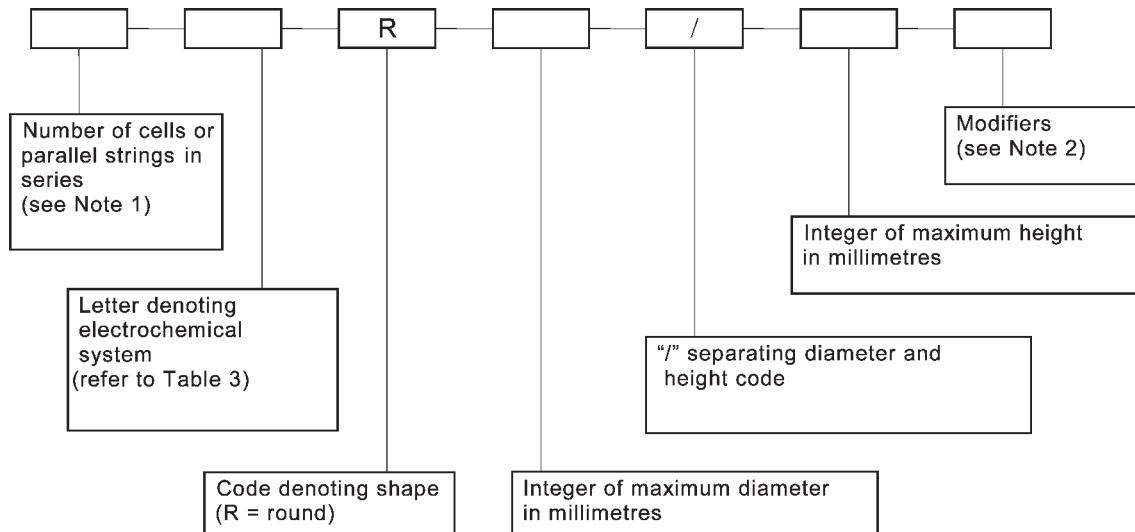


NOTE — The hundredths of a millimetre code is only used when needed.

Table 14), and a maximum height of 1.67 mm (see Table 16), of the zinc-alkali metal hydroxide-manganese dioxide system.

C-2.1.2 Round Batteries with Diameter and/or Height Over or Equal to 100 mm

The designation for round batteries with a diameter and/or height ≥ 100 mm is as shown in Fig. 4.



NOTES

- 1 The number of cells or strings in parallel is not identified.
- 2 Modifiers are included to designate, for example, specific terminal arrangement, load capability and further special characteristics.

FIG. 4 DESIGNATION SYSTEM FOR ROUND BATTERIES: $\emptyset \geq 100$ mm; HEIGHT $A \geq 100$ mm

C-2.1.2.1 Method for assigning the diameter code

The diameter code is derived from the maximum diameter.

The diameter code number is the integer of the maximum diameter of the battery expressed in millimetres.

C-2.1.2.2 Method for assigning the height code

The height code is the number denoting the integer of the maximum height of the battery, expressed in millimetres.

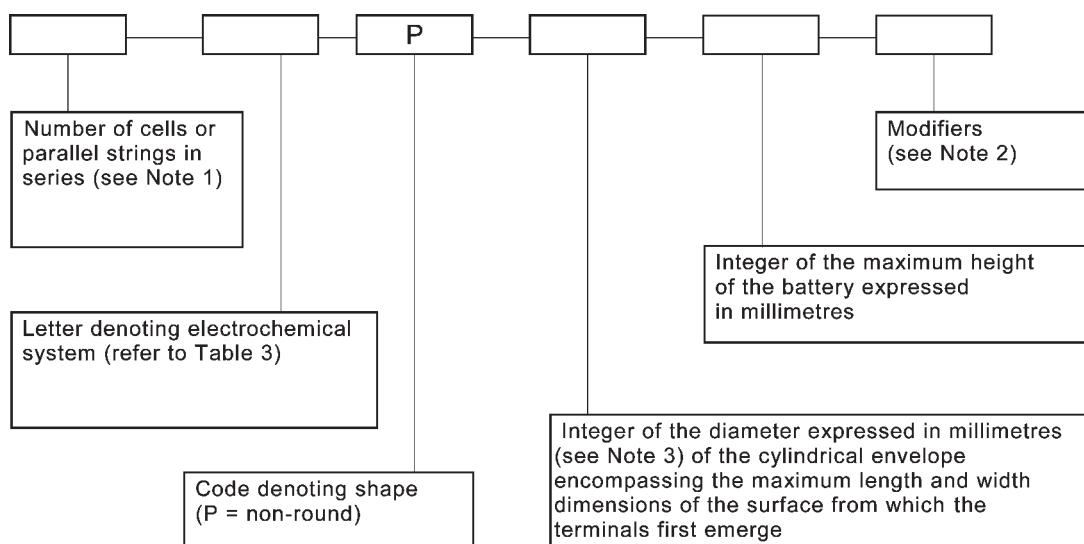
The maximum height is specified as follows:

- a) for flat contact terminals, the maximum height is the overall height including the terminals; and
- b) for all other types of terminals, the maximum height is the maximal overall height excluding the terminals (that is shoulder-to-shoulder).

Example — 5R184/177: A round battery consisting of five cells or strings in parallel of the zinc-ammonium chloride, zinc chloride-manganese dioxide system, connected in series, having a diameter of 184.0 mm and a shoulder-to-shoulder maximum height of 177.0 mm.

C-2.2 Non-round Batteries

C 2.2.1 The designation system for non-round batteries is as follows:

**NOTES**

1 The number of cells or strings in parallel is not identified.

2 Modifiers are included to designate, for example, specific terminal arrangement, load and further special characteristics.

3 In case the height needs to be discriminated in tenths of a millimetre, the letter code shown in Table 17 applies.

FIG. 5 DESIGNATION SYSTEM FOR NON ROUND BATTERIES, DIMENSIONS <100 mm

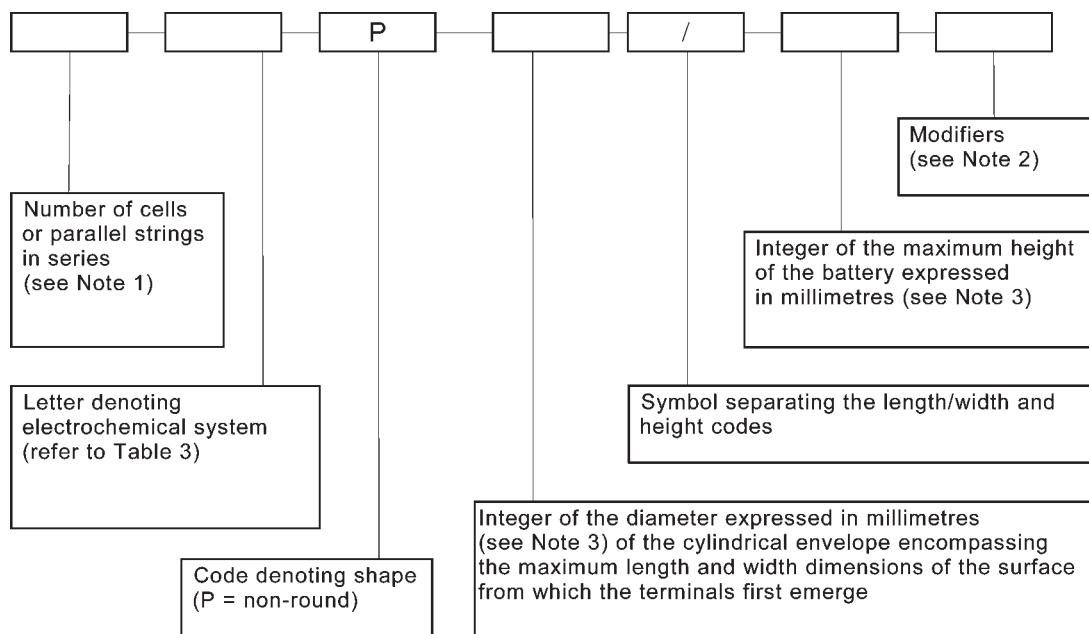
Example — 6LP3146: A battery consisting of six cells or strings in parallel of the zinc-alkali metal hydroxide-manganese dioxide system, connected in series with a maximum length of 26.5 mm, a maximum width of 17.5 mm and a maximum height of 46.4 mm.

The integer of the diameter of this surface (l and w) is calculated according to:

$$\sqrt{l^2 + w^2} = 31.8 \text{ mm}; \text{integer}=31.$$

C-2.2.3 Non-round Batteries with Dimensions $\geq 100 \text{ mm}$

The designation for non-round batteries with dimensions $\geq 100 \text{ mm}$ is as shown in Fig. 6.



NOTES

- 1 The number of cells or strings in parallel is not identified.
- 2 Modifiers are included to designate, for example, specific terminal arrangement, load and further special characteristics.
- 3 In case the height needs to be discriminated in tenths of a millimetre, the letter code shown in Table 17 applies.

FIG. 6 DESIGNATION SYSTEM FOR NON-ROUND BATTERIES, DIMENSIONS $\geq 100 \text{ mm}$

Example — 6P222/162: A battery consisting of six cells or strings in parallel of the zinc-ammonium chloride, zinc chloride-manganese dioxide system, connected in series, with a maximum length of 192 mm, a maximum width of 113 mm, and a maximum height of 162 mm.

C 2.3 Ambiguity

In the unlikely event that two or more batteries would have the same diameter of the encompassing cylinder and the same height, the second one will be designated with the same designation extended with ‘-1’.

Table 17 Height Code for Discrimination per Tenth of a Millimetre
(*Clauses C-2.2.1 and C-2.2.2*)

Decimal part of height mm	Code
0.0	A
0.1	B
0.2	C
0.3	D
0.4	E
0.5	G
0.6	H
0.7	J
0.8	K
0.9	L

NOTE — The tenths of a millimetre code is only used when needed.

ANNEX D

(Clause 4.1.7)

STANDARD DISCHARGE VOLTAGE U_s — DEFINITION AND METHOD OF DETERMINATION

D-1 DEFINITION

The standard discharge voltage U_s is typical for a given electrochemical system. It is a unique voltage in that it is independent of both the size and the internal construction of the battery. It only depends on its charge-transfer reaction. The standard discharge voltage U_s is defined by:

$$U_s = \frac{C_s}{t_s} \times R_s \quad \dots 1$$

where

- U_s = standard discharge voltage;
- C_s = standard discharge capacity;
- t_s = standard discharge time; and
- R_s = standard discharge resistor.

D-2 DETERMINATION

D-2.1 General Considerations: The C/R-Plot

The determination of the discharge voltage U_d is accomplished via a C/R -plot (where C is the discharge capacity of a battery; R is the discharge resistance). For illustration, see Fig 7, which shows a schematic plot of discharge capacity C versus discharge resistor R_d (see Note 1) in normalized

presentation, that is $C(R_d)/C_p$ is plotted as a function of R_d . For low R_d -values, low $C(R_d)$ -values are obtained and vice-versa. On the gradual increase of R_d , discharge capacity $C(R_d)$ also increases until finally a plateau is established and $C(R_d)$ becomes constant (see Note 2):

$$C_p = \text{constant} \quad \dots 2$$

which means $C(R_d)/C_p = 1$ as indicated by the horizontal line in Fig. 7. It further shows that capacity $C = f(R_d)$ is dependent on the cut-off voltage U_c : the higher its value, the larger is fraction ΔC that cannot be realised during discharge (see Note 3).

The discharge voltage U_d is determined by Equation (3).

$$U_d = \frac{C_d}{t_d} \times R_d \quad \dots 3$$

NOTES

- 1) Subscript d differentiates this resistance from R_s ; see equation (1).
- 2) For very long periods of discharge time C_p may decrease due to the battery's internal self-discharge. This may be noticeable for batteries having a high self-discharge, for example 10 percent per month or above.
- 3) Under plateau conditions, capacity C is independent of R_d .

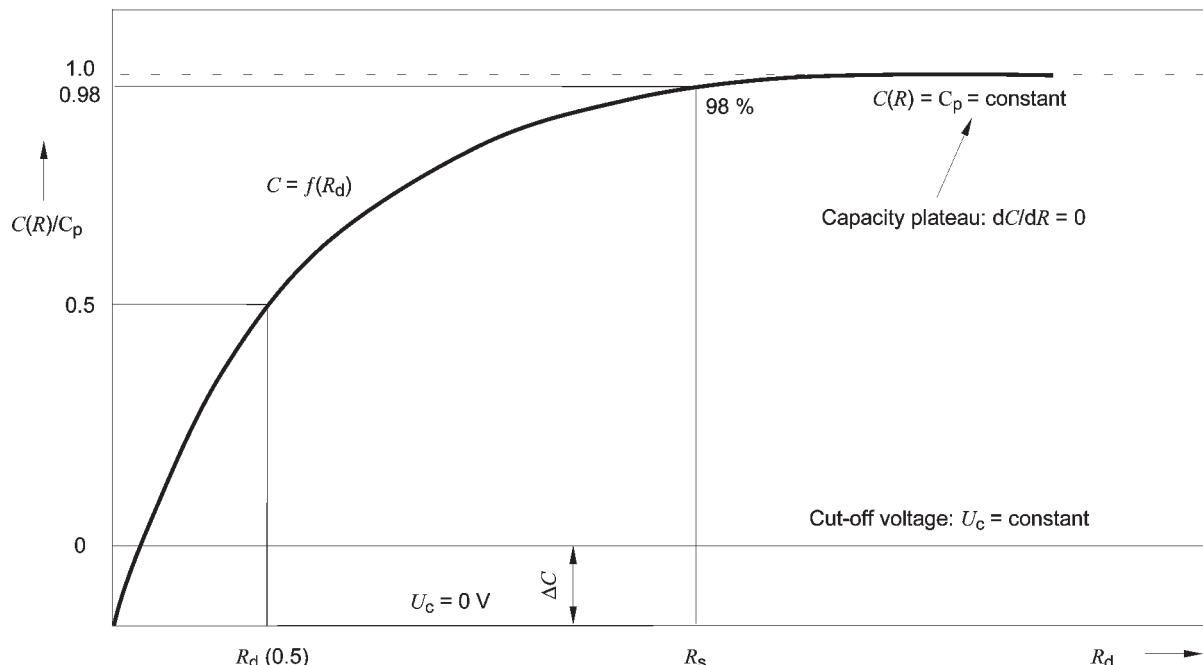


FIG. 7 NORMALIZED C/R-Plot (SCHEMATIC)

The quotient C_d / t_d of Equation (3) represents the average current $i(\text{avg})$ when discharging the battery through discharge resistor R_d for a given cut-off voltage $U_c = \text{constant}$. This relation may be written as:

$$C_d = i(\text{avg}) \times t_d \quad \dots 4$$

For $R_d = R_s$ (standard discharge resistor) Equation (3) changes to the Equation (1), and consequently Equation(4) changes to:

$$C_s = i(\text{avg}) \times t_s \quad \dots 5$$

The determination of $i(\text{avg})$ and t_s is accomplished according to the method described in **D-2.3** and illustrated by Fig. 8.

D-2.2 Determination of the Standard Discharge Resistor R_s

The determination of U_s is best achieved by that discharge resistor R_d , that yields 100 percent capacity realization. The time to perform this discharge may be of long duration. To reduce this time, a good approximation for U_s is achieved by Equation(5).

$$C_s(R_s) = 0.98 C_p \quad \dots 6$$

This means that 98 percent capacity realization is considered to be of sufficient accuracy for the determination of the standard discharge voltage U_s . This is achieved when discharging the battery through the standard discharge resistor R_s . Its factor

0.98 or above is not decisive, because U_s remains practically constant for $R_s \leq R_d$. Under this condition, the exact realization of a 98 percent capacity realization is not crucial.

D-2.3 Determination of the Standard Discharge Capacity C_s and Standard Discharge Time T_s

For illustration, see Fig. 8, which represents a schematic discharge curve of a battery.

Figure 8 addresses areas A_1 below and A_2 above the discharge curve. Under the average discharge

$$A_1 = A_2 \quad \dots 7$$

current $i(\text{avg})$ is obtained. The condition described by Equation (7) does not necessarily address the mid-point of discharge, as indicated in Fig 8. The time of discharge t_d is determined from the cross-over point for $U(R,t) = U_c$. The discharge capacity is obtained from Equation (7).

$$C_d = i(\text{avg}) \times t_d \quad \dots 8$$

The standard capacity C_s is obtained for $R_d = R_s$, changing Equation (8) to Equation (9).

$$C_s = i(\text{avg}) \times t_s \quad \dots 9$$

a method which permits the experimental determination of the standard discharge capacity C_s and the standard discharge time t_s , needed for determination of the standard discharge voltage U_s [see Equation (1)].

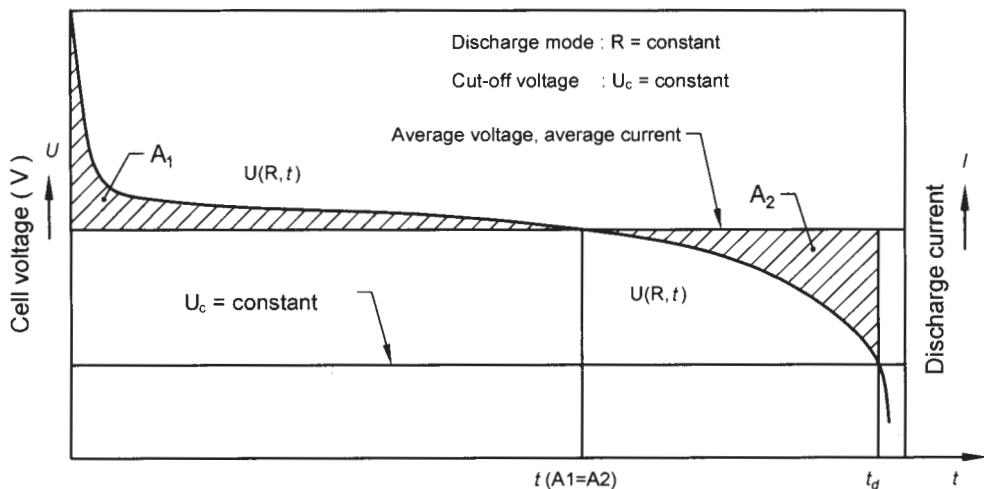


FIG. 8 STANDARD DISCHARGE VOLTAGE (SCHEMATIC)

**Table 18 Standard Discharge Voltage by System
(Clause D-3)**

System letter (1)	No Letter (2)	C (3)	E (4)	F (5)	L (6)	S (7)	Z (8)
U_S V	1.30	2.90	3.50	1.48	1.30	1.55	1.56

D-3 EXPERIMENTAL CONDITIONS TO BE OBSERVED AND TEST RESULTS

For the experimental determination of the C/R -plot, 10 individual discharge results are recommended, each one being the average of nine batteries; these data are to be evenly distributed over the expected range of the C/R -plot. It is recommended to take the first discharge value at approximately $0.5C_p$ as indicated in Fig. 7. The last experimental value should be taken at approximately $R_d \approx 2 \times R_s$. The data gathered may then be graphically presented in the form of a C/R -plot according to Fig. 7. From this plot the R_d -value is to be determined leading to approximately 98 % C_p . The standard discharge voltage U_S yielding a 98 % capacity realization should deviate by less than -50 mV from that value yielding a 100 % capacity realization. Differences within this mV range will only be caused by the charge-transfer reaction caused by the system under investigation.

When determining C_s and t_s according to D-2.3, the following cut-off voltages are to be employed in accordance with individual battery specifications :

For Voltage range 1: $U_C = 0.9$ V

For Voltage range 2: $U_C = 2.0$ V

The following experimentally determined standard discharge voltages U_S (SDV) (see Table 18) are only given to permit the interested expert to check its reproducibility:

The determination of U_S for systems A, B, G and P is under consideration. System P is a special case, because its U_S value depends on the type of catalyst for oxygen reduction. Since system P is an open system to air, the environmental humidity as well as the pick-up of CO_2 after the activation of the system, is of additional influence. For system P, U_S values of up to 1.37 V may be observed.

ANNEX E

(Clause 5.1)

PREPARATION OF STANDARD METHODS OF MEASURING PERFORMANCE (SMMP) OF CONSUMER GOODS**E-1 INTRODUCTION**

Information useful to consumers on the performance of consumer goods needs to be based on reproducible standard methods of measuring performance (that is test methods that lead to results having a clear relationship to the performance of a product in practical use and that are to be used as a basis for information to consumers about the performance characteristics of the product).

As far as possible, specified tests should take into account limitations in test equipment, money and time.

E-2 PERFORMANCE CHARACTERISTICS

The first step in the preparation of a SMMP is to establish as complete a list as possible of the characteristics that are relevant in the sense discussed in **E-1**.

NOTE — Once such a list has been drawn up, consideration should be given to selecting those attributes of a product that are most important to consumers making purchase decisions.

E-3 CRITERIA FOR THE DEVELOPMENT OF TEST METHODS

A test method should be given for each of the performance characteristics listed. The following points should be taken into consideration:

- a) Test methods should be defined in such a way that the test results correspond as closely as possible to the performance results as experienced by consumers when using the product in practice;
- b) It is essential that the test methods are objective and give meaningful and reproducible results;
- c) Details of the test methods should be defined with a view to optimum usefulness to the consumer, taking into account the ratio between the value of the product and the expenses involved in performing the tests; and
- d) Where use has to be made of accelerated test procedures, or of methods that have only an indirect relationship to the practical use of the product, the technical Committee should provide the necessary guidance for correct interpretation of test results in relation to normal use of the product.

ANNEX F

(Clause 5.4)

CALCULATION METHOD FOR THE SPECIFIED VALUE OF MINIMUM AVERAGE DURATION

The calculation method for specifying the value of the minimum average duration is as follows:

- a) Prepare minimum 10 weeks' data of duration values which are randomly selected.
- b) Calculate average ' \bar{x} ' of duration values 'x' of nine samples from each population.

NOTE — If some values are out of 3σ of that population, eliminate these values from the calculation of \bar{x} .

- c) Calculate the average $\bar{\bar{x}}$ of the above average values \bar{x} of each population and also $\sigma_{\bar{x}}$.

- d) Minimum average duration value to be provided by each country:

$$A: \bar{\bar{x}} - 3 \sigma_{\bar{x}}$$

$$B: \bar{\bar{x}} \times 0.85$$

Calculate both A and B; define the larger value of the above two as its minimum average duration.

ANNEX G

(Clause 8)

GUIDELINES FOR PACKAGING, SHIPMENT, STORAGE, AND USE OF PRIMARY BATTERIES

The greatest satisfaction to the user of primary batteries results from a combination of good practices during manufacture, distribution and use.

The purpose of this code is to describe these good practices in general terms. It takes the form of advice to battery manufacturers, distributors and users.

G-1 PACKAGING

The packaging shall be adequate to avoid mechanical damage during transport, handling and stacking. The materials and pack design shall be chosen so as to prevent the development of unintentional electrical conduction, corrosion of the terminals and ingress of moisture.

G-2 TRANSPORT AND HANDLING

Shock and vibration shall be kept to a minimum. For instance, boxes should not be thrown off trucks, slammed into position or piled so high as to overload battery containers below. Protection from inclement weather should be provided.

G-3 STORAGE AND STOCK ROTATION

The storage area should be clean, cool, dry, ventilated and weatherproof.

Batteries should not be stored next to radiators or boilers, nor in direct sunlight.

Batteries may be stored, fitted in equipment or packages if determined suitable by the battery manufacturer.

The height to which batteries may be stacked is clearly dependent on the strength of the pack. As a general guide, this height should not exceed 2.5 m for cardboard packs or 4 m for wooden cases.

The above recommendations are equally valid for storage conditions during prolonged transit. Thus, batteries shall be stowed away from ships' engines and not left for long periods in unventilated metal box cars (containers) during summer.

Batteries shall be dispatched promptly after manufacture and in rotation to distribution centres and on to the users. In order that stock rotation (first in, first out) can be practised, storage areas and displays shall be properly designed and packs adequately marked.

G-4 DISPLAYS AT SALES POINTS

When batteries are unpacked, care should be taken to avoid physical damage and electrical contact. For example, they should not be jumbled together.

Batteries intended for sale should not be displayed for long periods in windows exposed to direct sunlight.

The battery manufacturer should provide sufficient information to enable the retailer to select the correct battery for the user's application. This is especially important when supplying the first batteries for newly purchased equipment.

Test meters do not provide reliable comparison of the service to be expected from good batteries of different grades and manufacture. They do, however, detect serious failures.

G-5 SELECTION AND USE

G-5.1 Purchase

The correct size and grade of battery most suitable for the intended use should be purchased. Many manufacturers supply more than one grade of battery in any given size. Information on the grade most suited to the application should be available at the sales point and on the equipment.

In the event that the required size and grade of battery of a particular brand is not available, the IS designation for electrochemical system and size enables an alternative to be selected. This designation should be marked on the battery label. The battery should also clearly indicate the voltage, name or trade-mark of the manufacturer or the supplier, the date of manufacture, which may be in Code, or the expiration of a guarantee period, in clear, as well as the polarity ('+' and '-'). For some batteries, part of this information may be on the packaging (*see 4.1.6.2*).

G-5.2 Installation

Before inserting batteries into the battery compartment of the equipment, the contacts of both equipment and batteries should be checked for cleanliness and correct positioning. If necessary, clean with a damp cloth and dry before inserting.

It is of extreme importance that batteries are inserted correctly with regard to polarity ('+' and '-'). Follow

equipment instructions carefully and use the recommended batteries. Failure to follow the instructions, which should be available with the equipment, can result in malfunction and damage of the equipment and/or batteries.

G-5.3 Use

It is not good practice to use or leave equipment exposed to extreme conditions, for example radiators, or cars parked in the sun, etc.

It is advantageous to remove batteries immediately from equipment which has ceased to function satisfactorily, or when not in use for a long period (for example cameras, photoflash etc).

Be sure to switch off the equipment after use.

Store batteries in a cool, dry place and out of direct sunlight.

G-5.4 Replacement

Replace all batteries of a set at the same time. Newly purchased batteries should not be mixed with partially exhausted ones. Batteries of different electrochemical systems, grades or brands should not be mixed. Failure to observe these precautions may result in some batteries in a set being driven beyond their normal exhaustion point and thus increase the probability of leakage.

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This Indian Standard has been developed from Doc No.: ETD 10 (6901).

Amendments Issued Since Publication

Amendment No.	Date of Issue	Text Affected

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